Fresnel Lens Gamma Ray Telescope

Mission Success

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Code 302
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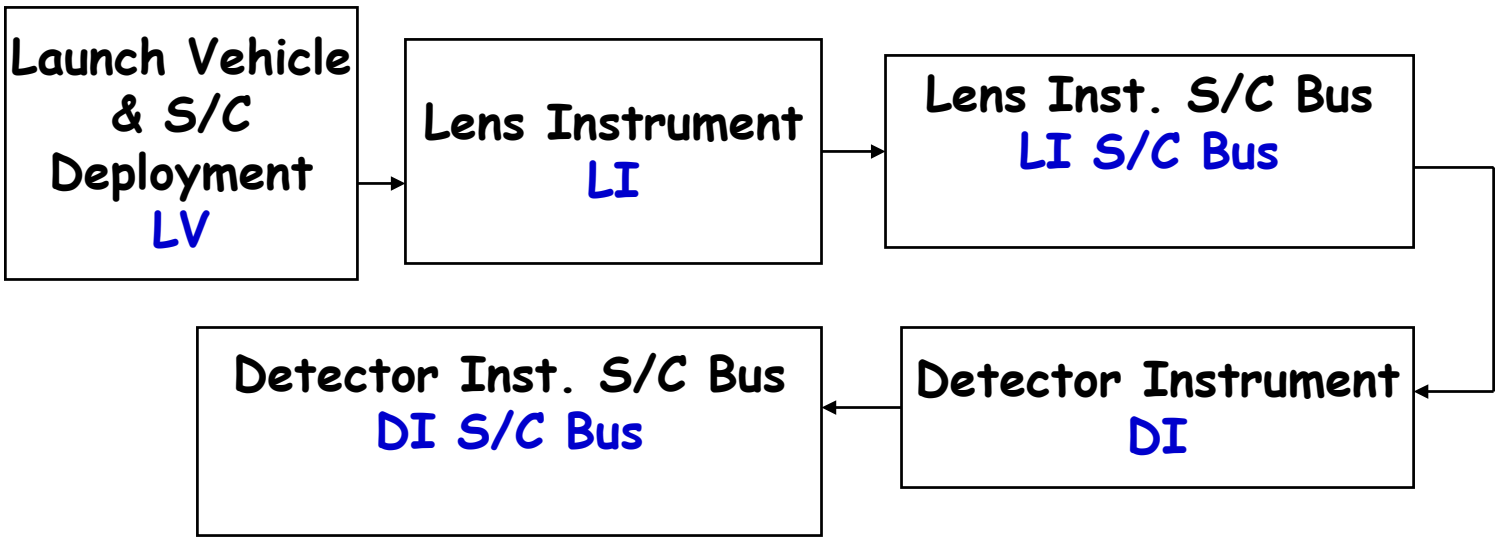
Summary

- Mission Success
  - Mission Success Expected To Be Medium - Low (60-70%)
  - Even Fully Redundant Spacecraft Systems Will Not Produce A High Mission Success Probability !
    - Both Lens & Detector Instruments Along With Both Spacecraft Busses Must Operate Successfully
  - Spacecraft Bus
    - S/C Bus Design Will Require A High Reliability By Redundancy
  - Instrument
    - Both Lens & Detector Instrument Design Should Be Able To Meet High Reliability
  - Launch Vehicle
    - New Delta 4 Should Have A High Success Ratio By FLGRT Launch Period
- System Safety
  - Laser Alignment Device Will Require Special I & T Safety
  - Propulsion Fluid of Xenon Would Not Be A Flammability Issue, But Could Become An I&T Air Displacement Hazard.
  - No Unusual Hazards
  - A US Launch Will Require Meeting AF EWR 127-1 Requirements

Assumptions

- **System Life**
  - 3 Yr Life & 5 Yrs for Consumables
- **Reliability Required**
  - None Stated
- **S/C Bus Redundancy**
  - Single Point Failures
    - All Components That Would Become Single Point Failures for Mission Success
      - Considered For Redundancy

Mission Success Reliability Block Diagram



Mission Success=

(LV) X (LI) X (LI S/C Bus) X (DI) X (DI S/C Bus)

Mission Success Estimate Chart

Quick Trial Run Calculation Estimate

Mission Life	Single S/C Rel.	Both S/C Rel.	Both S/C & Instruments	Mission Success Considers Launch Vehicle
3 Yrs	90 %	81 %	65.6 %	59%
5 Yrs	82 %	67 %	54.5 %	49%

Assumptions:

Launch Vehicle = 90% Reliability

Instruments = 90% Reliability

Gamma Ray Lens Instrument

- **Deployment Of Lenses**
  - Each Lens Deployment Should Be Independent Of Other.
  - There should Be At Least Two Ways To Deploy Or Mechinism Should Have Redundancy In Design.
- **Instrument Reliability Of 90% Should Be Attainable**
  - Lens Deployments
  - Lens Positioning
  - Laser Transmitter (Redundant Units)

Lens (Lens Craft) S/C Bus

- Propulsion
  - Redundancy
    - Cold Gas Only.
- RF Cross Link Between S/C
  - Dish Antenna—May not have To Deploy, Just Uncase
  - Cross Link Is Required For Proper Inter S/c Alignment & Mission Success
  - Station Keeping (ACS)
  - Redundancy In Design
- Data Storage & Down Load
  - Cross Link To Detector Bus Is Spared By Direct Link To Earth
- Laser Transmitter Device
  - Likely Life Limited—May Need To Be Turned Off During Gross Re Stationing To Lengthen Life
- Power
  - Battery
    - Consider Either Two Batteries In Parallel Or Extra Cells With By-Pass Switches
  - Solar Panels On S/C Bus
    - No Deployment Required
    - Design For Cross Strapping
- C&DH Module
  - Assume Standard Internal Redundant Unit

Detector Instrument Reliability

- **ISAL Reliability Initiatives**
  - PMT Reliability
    - Hamamatsu PMT Tubes—94.9-99.5% Reliability for 3 Yrs
      - Use This & Other Data To Size Array & Design Cross Strapping For Full Mission
    - Consider Turning Of Tubes When Function Not Needed To Increase Life
      - Reduced Voltage Also Increases Life
- **Instrument Reliability Of 90% Should Be Attainable**

Detector S/C Bus

- Propulsion
  - Redundancy
    - Four (4) High Power Ion Engine Thrusters
    - Eight (8) Medium Power Ion Engine Thrusters
  - Fuel Load
    - No Confirmation On Proposed Fuel Load vs Station Duty Service
- RF Cross Link Between S/C
  - Dish Antenna—My not have To Deploy, Just Uncase
- Station Keeping (ACS)
  - Design Has Good Redundancy
- Data Storage & Down Load
  - Fifteen minutes/day Is An RF Xmtr Duty Cycle Of Only 1%
    - Consider Less Component Redundancy & More Path Redundancy For Future Design
- Laser Receiver Device
  - Design For Two Sensors
  - Design For Alternate Method Of Aligning Detector
- Power
  - Battery
    - Design For Either Two Separate Batteries Or Extra Cells & By-Pass Switches
  - Solar Panels
    - Two Deployable Units
- C&DH Module
  - Assume Standard Internal Redundant Unit

Launch Vehicle Reliability

- **Delta 4 (US)**
  - Delta 4 LV Is Un Proven Launch Vehicle, but Has AF Commitment
  - Delta 4 LV Components (Most) Are Launch Proven
  - Likely >90% In Several Years

- **Ariane 5 (French)**
  - Eleven (11) Launches With Two (2) Failures
  - First Launch Was Failure From Improper Reuse of S/W.
  - Ariane 5 Claims 85.7%
  - 9 Out Of 11 is 81.8%

- **S/C Deployments**
  - Both S/C Must Fully Separate, Deploy & Release Cocoon For Mission Success
  - S/C Must Be Deployed In Proper Orbit For Mission Success

System Safety

- **If Launched at US AF Launch Facility**
  - EWR 127-1 Standard Range Safety Requirements

Mission Success
NASA HQ Required
PRA Work

NASA HQ Will Require PRA Work For Mission

Perform Single Point Failure Analysis
Reliability Predictions
Will The Mission Design Likely Meet the Goals For Life Expectancy
Start Low Level System Engineering Support At Phase A
Redundancy Calculations FFMECA-Failure Modes & Effects & Criticality Analysis Early In Design
NASA HQ Might Require A Fault Tree Analysis For This Larger & More Expensive Project
Trade-Offs can be made among subsystem/instrument elements using the Reliability Prediction to achieve the system goal
Determine If Redundancy are selected efficiently

Expected NASA HQ Require PRA Level Of Effort For FLGRT Mission

Higher Cost Missions (>$100Million)

- **Limited Scope PRA Effort**
- **Examples (EOS, SIM, EO-1)**

♦ Note Level Of PRA Effort Required Could Increase If Considered A National Asset Or Similar Designation

Orbital Debris

Orbital Debris

- DeOrbit (S/C Disposal)
  - Not An Issue In FLGRT Space Location
- Jettison Of S/C Covers & Other Items
  - Not An Issue In FLGRT Space Location
- Launch & Deploy
  - Not Considered Yet

Future Program Costs Related To Mission Success & System Safety

- **Safety Data Package For Both Instruments**
  - Likely Done By Builder Of Instrument
  - Est. 3 Yrs @ 20% FTE + 2 Yrs @ 50% FTE—(All Time 2)
- **Safety Data Package For Both Spacecraft Buses**
  - Likely Done By Designer & Builder Of New Spacecraft Bus
  - Est. 3 Yrs @ 50% FTE X 2
- **Summary**
  - Over 5 Yrs, XXM$ For R & S

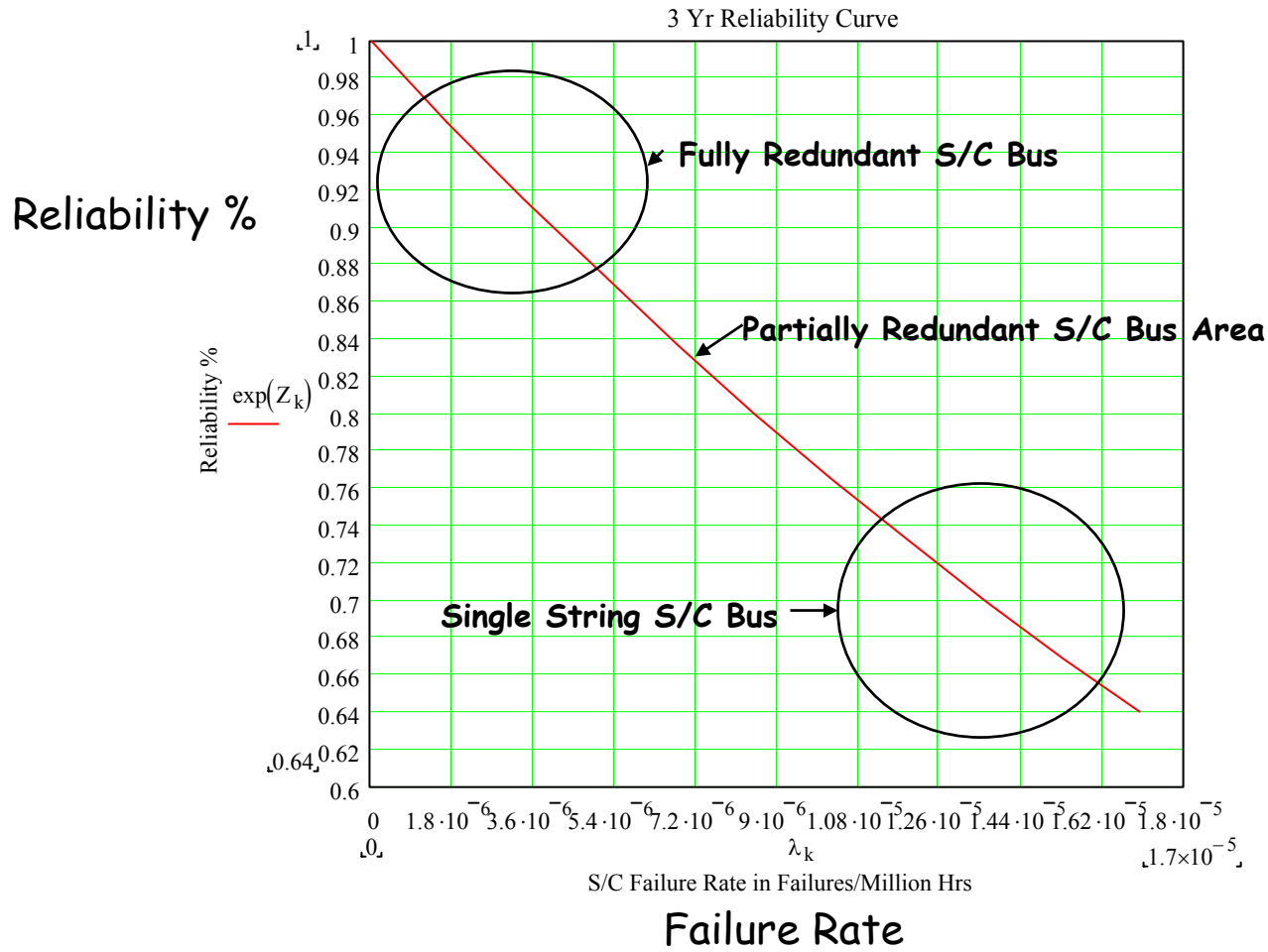
FTE=Full Time Engineer = XXK for GSFC System Safety or Reliability

Back Up Slides

- Extra Slides With Additional Information

Single S/C 3 Year Bus Reliability

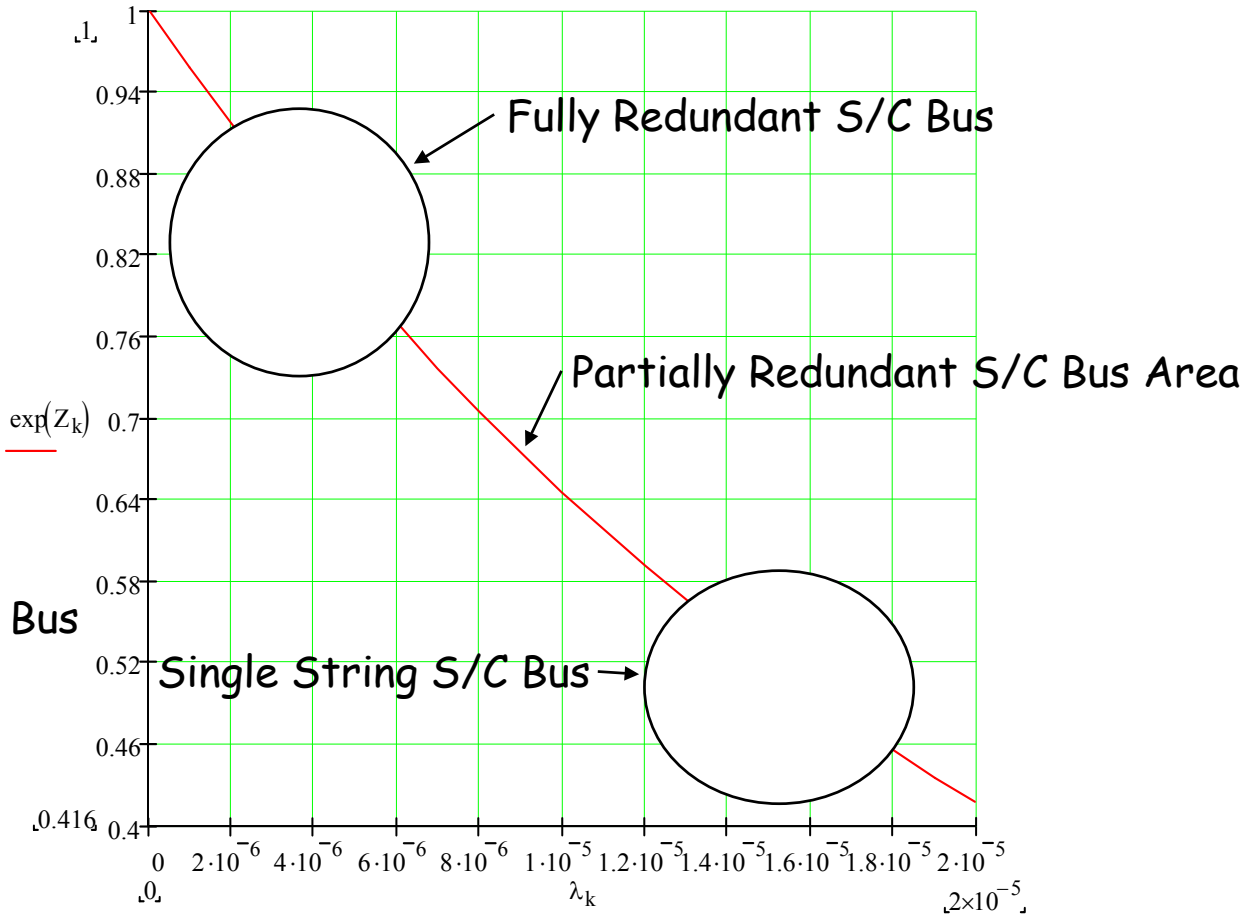
3 Year Mission—Spacecraft Bus Only (Based On RSDO S/C Bus Reliability Info)



Spacecraft Bus Redundancy
Single S/C

5 Year Mission---Spacecraft Bus Only

Reliability %



Based On RSDO S/C Bus Reliability Info.

S/C Bus Failure Rate—Failures per X Hrs

Mission Success Estimate Calculation

Mission Success= (LV) X (LI) X (LI S/C Bus) X (DI) X (DI S/C Bus)

- **LV**
  - Assume 85.7% For Delta 4
  - Note: Separation Reliability Not Considered Here.
- **LI**
  - Assume 90%
- **LI S/C Bus**
  - Assume 90% @ 3 Yrs For Fully Redundant Bus
- **DI**
  - Assume 90%
- **DI S/C Bus**
  - Assume 90% @ 3 Yrs For Fully Redundant Bus
- Mission Success = 0.857 X 0.9 X 0.9 X 0.9 X 0.9 = 56.2%
  - Not considering the Launch Vehicle In Mission Success, nor Deployment
    - On Orbit Mission Success = 65.6%